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ABSTRACT

This study was conducted to relate personal, cognitive, and school variables to physics achievement. The sample consisted of 435 students participating in the 1985 Mississippi State University Annual Physics Competition. The Student Background Questionnaire was planned and developed to collect information on each variable examined. The predictor variables studied were pupil gender, composite score on the American College Test (ACT), ACT science score, ACT math score, number of laboratories per semester, type of laboratory work (demonstrations or small group), number of physics courses offered by high school, class size, number of girls in a class, career plans, and types of mathematics courses taken by the students. The correlation between physics achievement and each variable was determined. Multiple regression was used to determine what combination of variables would serve as the best predictor of physics achievement. The best combination set of predictor variables were: composite ACT scores, sex, calculus having been taken by the student, science ACT score, number of physics classes offered by school, and the type of laboratory work. The composite ACT score was the best predictor of physics achievement. (PN)

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Factors Contributing to Achievement in Statewide Physics Competition

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Factors Contributing to Achievement in Statewide Physics Competition

A recent trend in education is to base an instructional program on measures of student performance (Lawrenz, 1975). Student achievement is often used as a major factor in determining teacher effectiveness. An increased emphasis on science and an increase in the number of students enrolling in science courses have resulted in a need for teachers capable of providing instruction in secondary science. Securing qualified teachers to provide this instruction, particularly in the area of physics, is a national problem (Lashier & Ryoo, 1984; Shymansky & Aldridge, 1982; Williams, Howard, McDonald, & Michael, 1984).

Studies have been done examining teacher characteristics (Aiello-Nicosia, Sperando-Mineo, & Valenza, 1984; Druva & Anderson, 1983; Lawrenz, 1975), but no research has been conducted relating teacher and student variables to student achievement in physics. This study was conducted to relate personal, cognitive, and school variables to physics achievement. The researchers hypothesized that no combination of the following variables would correlate significantly with physics achievement: pupil gender, composite score on the American College Test (ACT), ACT science score, ACT math score, number of laboratory experiments per semester, type of laboratory work (demonstrations or small group), number of physics classes offered by the school, teacher gender, class size, number of females in a class, career plans, and type of mathematics courses taken by the pupils.

Method

Subjects

Each year the Mississippi State University Physics Department

invites students enrolled in Mississippi schools to participate in their Annual Physics Competition. The sample consisted of the 435 students participating in the 1985 Mississippi State University Annual Physics Competition. Sixty percent of the sample was male and 40% female.

Instruments

The Student Background Questionnaire was planned and developed by the researchers to collect information on each of the variables examined in the study. Four science educators analyzed the questionnaire to determine content validity.

Achievement in physics was measured by the Mississippi State Physics Competition Test, Forms 1 & 2. Content validity of the test was established by the expertise of the test developers, members of the Mississippi State University Physics Department. The test reliability, as determined using Cronbach's Alpha, was 0.84 for Form 1 and 0.86 for Form 2.

Method of Data Collection and Analysis

Data were collected in the spring of 1985 at the Mississippi State University Annual Physics Competition. At the time of the competition, a one-page questionnaire, The Student Background Questionnaire, was administered to the students by Mississippi State University Physics Department personnel. Students were asked to respond to questions about the variables under consideration in this study. The results of the study are limited to the cognition of the students.

Data were analyzed through the use of a simple correlation to determine the correlation between physics achievement and each variable. Multiple regression was used to determine what combination of variables would serve as the best predictor of physics achievement.

Results

To determine what correlation, if any, would be found between each of the variables and achievement in physics, a Pearson-product moment correlation was computed independently for each variable (see Table 1). Significant correlations at the .01 level included gender ($r = -.32$), composite ACT score ($r = .49$), science ACT score ($r = .46$), math ACT ($r = .46$), the student's having had trigonometry ($r = .28$), and the student's having had calculus ($r = .32$). The number of physics classes offered by the school was significant at the .05 level ($r = .22$). The negative correlation for gender indicates that boys score higher than girls.

The major research question was to determine what combination of the selected variables would serve as the best predictor of achievement in physics. The predictor variables studied were pupil gender, composite ACT score, science ACT score, math ACT score, the number of laboratories per semester, the type of laboratory work (demonstration or small group), the number of physics classes offered by the high school, class size, the number of girls in a class, career plans, and type of mathematics courses taken by the students.

Table 2 provides a list of the predictor variables. Each of seven variables explained at least one percent of the variance in the students' scores on the Mississippi State University Physics Competition Test and were included in the best combination set of predictor variables. These variables were composite ACT score, gender, calculus having been taken by the student, science ACT score, the number of physics classes offered by the school, and the type of laboratory work.

Composite ACT score was the best predictor of physics achievement,

explaining 24.43% of the variance. The F-value was 139.97, significant at the .01 level. The gender of the student explained an additional 8.61% of the variance. The F-value of 55.51 was significant at the .01 level. An additional 2.04% of the variance was explained by calculus having been taken by the student. The F-value was 13.51, significant at the .01 level. Science ACT score explained another 1.91% of the variance with an F-value of 13.02, significant at the .01 level. The number of physics classes in the high school accounted for an additional 1.51% of the variance producing an F-value of 10.55, significant at the .01 level. The type of laboratory work, explaining an additional 1.76% of the variance, had an F-value of 12.61, significant at the .01 level. The entire predictor set explained 40.25% of the variance. The F-value of 48.06 was significant at the .01 level (df 6, 428).

These data show that students who score higher on the Mississippi State University Physics Competition Test are typically males with a high composite ACT score and a high ACT science score. They have taken calculus, are from a school having several physics classes, and their high school laboratory experience consisted of experiments conducted in small groups.

Implications

As schools are required to provide more laboratory-based sciences for their students and as required laboratory time is increased, science educators and administrators must be concerned about the type of laboratory work done by students. As an independent variable the type of laboratory work did not correlate significantly. However, when considered as a part of a set of predictor variables, small group laboratory work as opposed to demonstrations becomes important.

Many teachers use demonstrations or large group experiments in science, particularly in physics, because of the lack of adequate science equipment in their schools. The results of this study indicate a need for small group laboratory work to promote achievement in physics.

Table 1

Simple Correlation Between Achievement in Physics and Personal, Cognitive, and School Variables

Variable	r
Gender	-.32**
Composite ACT Score	.49**
Science ACT Score	.46**
Math ACT Score	.46**
Number of Labs per semester	.16
Type of Lab Work	.14
Number of Physics Classes in School	.22*
Teacher Gender	.12
Career Plans	.06
Algebra I	.06
Algebra II	.14
Plane Geometry	.14
Trigonometry	.28**
Calculus	.32**

*p < .05
**p < .01

Table 2

Predicting Physics Achievement for High School Students Through Personal, Cognitive, and School Variables

Variable	R	R^2	R^2 added	Simple r	df	F to enter
Composite ACT	.4943	.2443	.2443	.49	1,433	139.97*
Gender	.5748	.3303	.0861	-.32	1,432	55.51*
Calculus	.5922	.3507	.0204	.32	1,431	13.51*
Science ACT	.6081	.3698	.0191	.46	1,430	13.02*
Number of Physics Classes in School	.6204	.3849	.0151	.22	1,429	10.55*
Type of Laboratory Work	.6344	.4025	.0176	.14	1,428	12.61*
Total Predictor Set	.6344	.4025			6,428	48.06*

*$p < .01$

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